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Investigations on the epidemiology of toxoplasmosis by means of intradermal test

Badania nad epidemiologią toksoplazmozy przy pomocy próby śródskórnej

In spite of considerable interest maintained for many years in the problem of toxoplasmosis too little is known of the epidemiology of the disease, rautes of invasion of the human being, the actual frequency of invasions in various environments and of factors which exert an influence on it. Diverse reservoirs of the microorganism in the Nature among numerous animals living in the free state and under domesticated conditions prove that the distribution of the organism is fairly extensive. From experiments conducted up to now it is known, that the parasite may reach the external environment by means of the urine, faeces, milk, mucous discharge, superficial necrotic foci and them like. At the same time a high susceptibility of the parasite to diverse physical and chemical factors was stated. Recently a great role is attached to the invaded meat. Weinman and Chandler (1956) attempt to prove that pork is an important factor in the spreading of toxoplasmosis. Detection of toxoplasmas in the ovaries of hens (Biering-Sørensen) suggests that also eggs may play here a certain role. The observations are not numerous and as yet it is not known, which of the routes of excretion is essential in the Nature.

Even less is known of the routes of invasion of the parasites into a new host. The possibility of oral, respiratory, through the mucous membrane of the eye or vagina were experimentally proved as routes of entry. It is supposed that intact skin may sometimes serve also as a way of entrance. Results of studies of blood sucking arthropoda are not convincing. It is known that toxoplasmas may survive in some artificially invaded arthropoda, as e. g. in *Ornithodorus mouba-*

ta up to 23 days (Havlik, 1951), in *Rhipicephalus sanguineus* up to 60 days (Jacobs, 1956), in *Culex quinquefasciatus* up to 96 hours (Giovannoni et al., 1952), in *Stomoxys calcitrans* up to 22 hours (Laarman, 1956), but only in a single case was it possible to transfer the invasion onto a new host, stung by *Dermacentor* (Woke, Jacobs, Jones and Melton, 1953). Detection of invaded arthropoda in the Nature (Giroud et al., 1953) encourages even more to follow the course of such studies. At present this problem is not yet solved and natural routes of invasions of the man and animals, excepting the innate forms remain still not clear.

Direct research and studies are very difficult. To prove the fact it can be stated that hitherto not a single case of naturally acquired toxoplasmosis is known, in which the actual route of entry of the parasite could be established. Fairly often the contact with affected animals, mainly dogs and cats is suggested but it is not possible to define precisely the circumstances. Even in the relatively numerous cases of laboratory invasions it is not always easy to find out the moment and route of invasion. Sometimes only the fact of pricking with a needle, spurting of the material into the eye, or swallowing of an invaded material (exudate) taken into the mouth by means of a pipette is reported.

In view of the mentioned difficulties indirect studies of the epidemiological type including larger groups of people are indispensable. In such studies the differences are explained by diverse epidemiological conditions and at the same time new lines for further, more precise studies are revealed.

Studies of such a type are conducted since 1948 that is, since the introduction of serological tests (dye-test of Sabin-Feldman, the complement fixation test — C.F.T.) and the intradermal test. They are fairly numerous and include various areas of the world. Two courses can be discerned among them: studies of limited clinical groups or persons with certain pathological lesions and studies of an average normal human community.

Results of the first group of studies are as far very fruitful. Attention was drawn to new, hitherto unknown forms of toxoplasmosis. I should remind that Frenkel (1949) using the intradermal tests turned attention to cases of uveitis and chorioretinitis in adults who were closely examined and presently are in the majority regarded

as being caused by toxoplasmosis. The interesting studies by Jirovec (1957) follow the same course. He studies the reactivity mainly among groups of children of Mongols, suffering from endarteritis obliterans, women suffering from habitual abortions etc. Previously we used the same method examining patients suffering from psychic disorders (Kozar, 1953) and later examining in detail a group of oligophrenics (Kozar, Dłużewski, Dłużewska, and Jaroszewski, 1954). Considerably more works performed by the use of the above mentioned method could be mentioned here. They undoubtedly contributed towards the accumulation of data concerning the role of toxoplasmosis (Zeipel and Linder, 1951; Krieg, 1951; Buhn, 1952; Hein, 1952; Kunert and Jüptner, 1952; Fois and Vullo, 1952; Garin, 1953; Pigeaud et al., 1953; Bertram, 1955; Petrovicky and Kvapilik, 1955; Vojtechovska, Vojtechovsky and Petru, 1956, and others).

Studies conducted on normal population proved surprisingly frequent invasions of the whole communities. A considerable disproportion between the number of cases clinically diagnosed and symptom free invasions indicates that the human population is highly tolerant to toxoplasmosis. Among the invaded only few show symptoms of the disease, what may be explained by differences of the virulence of the separate strains, dose, route of entry of the parasite, individual characteristics of the host and a number of other factors.

If in accordance with the opinion of the majority of investigators we regard the presently employed methods as reliable then we can already treat the distribution of toxoplasmosis as cosmopolitan. In the separate regions, however, there appear differences. In northern areas (northerly part of Sweden, Alaska and Iceland) invasions occur considerably rarer than in the southern areas. The inhabitants of the eastern parts of the United States of America show on the whole a higher percentage than those of the western parts. Unusually high percentages were found among the inhabitants of Tahiti and Guatemala; extremely low — among Indians of the tribe Navajo, inhabitants of the State Arizona. However, the Indians of the tribe Guambia in Columbia react positively in 29.6 per cent. Among the inhabitants of Algeria there were found 10 per cent positivily reacting and among the Negroes of the Bantu tribe in South Africa 31.1

per cent. In spite of certain fluctuations it seems that toxoplasmosis occurs more frequently in warm and humid areas than in the cold or warm and dry areas. On the whole, the frequency of invasion depends on the age of the examined persons. Sometimes a gradual increase of the percentage till the climactic group of the age 30—40—50 is observed. Dependence of invasion on the sex, race, profession, contact with invaded animals, locality was traced.

Unfortunately in spite of the publication of numerous papers on this theme we still lack a clear epidemiological picture of the disease. It is difficult to compare the results of the separate studies because different methods of examinations were employed. In the majority the dye-test or the C.F.T. were employed. Both although still serve for the diagnosis of clinical cases evoke serious reservations as regards details of the methods. Individual laboratories use various methods of dilution in the dye-test and accept different criteria of the positive results. These and other details naturally reduce the value of epidemiological studies. Similarly different antigens used in the C.F.T. make the comparison of results difficult, not mentioning the relatively low resistance of antibodies of this type. It seems, therefore, that the most suitable is the method of intradermal reaction, which in respect to the performance as in the evaluation rise at present no major reservations.

The intradermal test introduced by F r e n k e l (1948) was initially not too favourably accepted. In 1951 and 1952 we conducted in Gdańsk exact studies on the intradermal test and we proved its suitableness both for individual diagnosis as well as for various mass examinations (K o z a r, 1953). Recently a constantly increasing number of investigators use the intradermal test stating, as we did its advantages (T h a l h a m m e r, 1953; F e l d m a n, 1953; V a r e l a, 1955; J i r o v e c, 1956, 1957 and others).

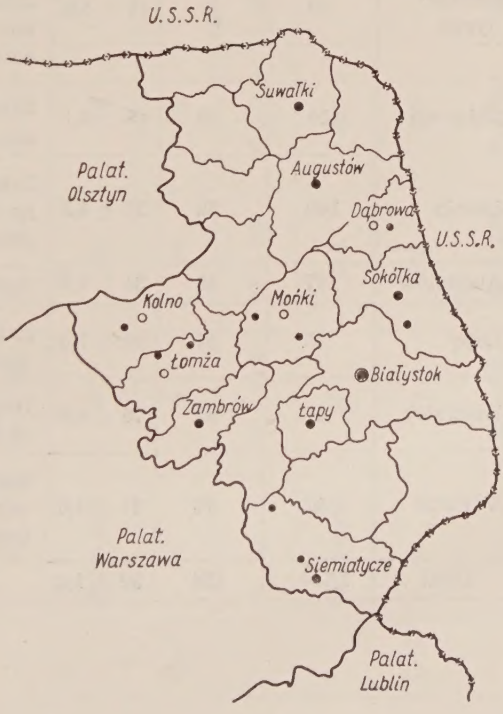
Polish studies of the epidemiological type initiated by us proved that the inhabitants of Gdańsk react to toxoplasmosis positively on an average in 25 per cent of cases (K o z a r, 1953). At that time we did not find distinct differences in the individual groups of age. This fact and the more frequent reactions of women than men we interpreted as being caused by the difference of epidemiological conditions, as e. g. a group of young women occupied a common lodging. Also the detection of this microcentre proves that the test is applicable.

Similar studies were undertaken by the Cracow centre (Starzyk and others, 1956) and enabled to detect high percentages of positive results among workers of abattoirs of that palatinate (preliminary report on the Vth Meeting of the Polish Parasitological Society).

To find out whether in Poland appear distinct epidemiological differences of toxoplasmosis we have undertaken similar studies in summer 1956 in the Białystok palatinate. A comparison of results from the northern (Gdańsk), southern (Cracow palatinate) and eastern (Białystok palatinate) regions may enable a closer analysis of the situation.

Material and methods

The studies were conducted almost on the whole terrain of the Białystok palatinate, because they were performed in 19 various localities, belonging to 10 districts. The enclosed map (draw. 1) illustrates the distribution of the examined localities within the palatinate. The human population of various age, mainly peasants were the object of studies. Included are here also inhabitants of boroughs, many of them are house-keepers and therefore are no less in contact with animals and their products than agricultural workers. Both healthy and suffering people in hospitals and admitted to health centres were examined. It is difficult in this respect to draw a demarcation line, because in the first group there were workers in factories, hospital personnel and peasants, who many a time complained as being affect-



Draw. 1. The distribution of the examined localities within the Białystok palatinate.

Table I
Results of studies in the individual localities

District (powiat)	Number of examined	Positive result		Notes
		Number	%	
Zambrów	419	80	19 ± 1,9	Workers in a textile factory, mainly youth, age about 18 years
Sokółka	134	31	23 ± 3,6	Hospital patients and inhabitants of the hamlet Wierchlesie (relatively many children)
Mońki	35	11	31 ± 7.8	Inhabitants of the hamlet Wilamówka and the settlement Knyszyn
Kolno	95	35	37 ± 4,9	Health Centre in Kolno and inhabitants of the hamlet Zabiele (youth relatively numerous)
Suwałki	76	33	43 ± 5,7	Patients and hospital personnel
Siemiatycze	70	31	44 ± 5,8	Hospital patients in Siemiatycze, inhabitants of the hamlet Koce and Czartajew (exclusively agricultual population).
Dąbrowa	154	69	45 ± 4,1	Inhabitants of the hamlet Różanystok
Łomża	140	72	51 ± 4,2	Inhabitants of the hamlet Kupnina and Karwowo, patients in hospitals in Łomża
Augustów	107	58	54 ± 4,8	Patients and hospital personnel
Łapy	45	27	60 ± 7,3	Patients and personnel of regional ambulatory
Białystok	42	32	76 ± 6,6	Hospital patients and inhabitants of the hamlet Świecie
Various	93	75	81 ± 4,0	Sanitary personnel, school of midwives from various localities, mainly from Łomża and Białystok
Total	1,410	554	39 ± 1,3	

Table II

Results of examinations according to age and sex

Sex	Age / Result	0 — 10	11 — 20	21 — 30	31 — 40	41 — 50	51 — 60	61 →	Total
♀♀	Examined	14	484	171	99	98	58	57	981
	+	6	172	76	54	56	32	31	427
	%	43 ± 13,2	35 ± 2,2	44 ± 3,8	56 ± 4,9	57 ± 5,0	55 ± 6,4	54 ± 6,6	44 ± 1,6
♂♂	Examined	13	130	90	50	65	46	35	429
	+	3	30	26	13	20	20	15	127
	%	23 ± 11,6	23 ± 3,7	29 ± 4,8	26 ± 6,2	31 ± 5,7	43 ± 7,3	43 ± 8,4	30 ± 2,9
♀♂	Examined	27	614	261	149	163	104	92	1 410
	+	9	202	102	67	76	52	46	554
	%	33 ± 9,3	33 ± 1,9	39 ± 3,0	45 ± 4,0	47 ± 3,9	50 ± 4,9	50 ± 5,2	39 ± 1,3

Table III

Relation of positive results to the profession of examined persons

Profession	Women			Men			Total		
	Examined	Positive		Examined	Positive		Examined	Positive	
		Number	%		Number	%		Number	%
Physical workers	324	82	25 ± 2,4	163	34	21 ± 3,2	487	116	24 ± 1,3
School youth	180	69	38 ± 3,8	77	21	27 ± 5,1	257	90	35 ± 2,9
Agiculture House-keeping	282	138	49 ± 2,9	149	55	37 ± 3,7	431	193	45 ± 2,4
Intelligentsia	26	12	46 ± 9,8	17	12	71 ± 11,0	43	24	56 ± 7,6
Sanitary personnel, physicians, nurses, midwives, workers in hospitals	167	119	71 ± 3,5	11	5	45 ± 15,0	178	124	70 ± 3,4
Total	979	420	43 ± 1,5	417	127	30 ± 2,2	1 396	547	39 ± 1,3

ed by various ailments and among the second group similar cases were admitted to mobile medical centres. Anyway, a group particularly suspected of toxoplasmosis could not be discerned among the patients, therefore the whole population should be treated as the average of the inhabitants of the palatinate.

The intradermal test served as the method of the studies. The employed antigen was produced by the author. Planning to perform a comparative analysis the same technic of studies was adopted, which was used previously in Gdańsk. Because all technical details were in the mentioned paper described, no mention is made of them presently (K o z a r, 1953).

R e s u l t s

A total number of 1,410 persons were examined and 554 (39%) of them were positively reacting. (Doubtful results were classified as negative results). In the table I is a tabular arrangement of results obtained in the various districts of the province, whereby in the column "notes" the locality, in which the studies were conducted and a characteristic of the examined group are given. The last position in the tabular arrangement "various" was separated, because the persons were inhabitants of other localities and temporarily were present in the locality, in which the examinations were conducted. It is a special group of workers of the health service and will be discussed separately.

The majority of the examined persons constituted women, of whom 981 were in comparison with the group of 429 men taken into consideration. Among the first group there were 427 positively reacting, what makes 44 per cent, while in the second group of men the corresponding results were 127 that is 30 per cent.

Table II illustrates positive results with toxoplasmin in various groups of age. Among 7 groups (every 10 years) the most numerous is the group of the age 11—20 years. Taking into consideration the relatively lower percentage of positive reactions of this group as compared with older groups, the probability of still higher total result should be accepted than 39 per cent. Separately are discussed results for women, men and the total.

Fairly large differences of results present in the table I encouraged us to take into consideration also the profession of the examined persons. To this purpose 5 different groups were separated. Into

consideration were taken factors which could influence the frequency of invasions as e. g. living conditions and character of work. A tabular arrangement including a total number of 1,396 persons: 979 women and 417 men is represented in table III.

In 1,326 persons the toxoplasmin was injected simultaneously with the trichinella antigen. This material constitutes a fragment of another work, dealing on the epidemiology of trichinellosis and including considerable more examined persons (Kozar, Kołłoto and Warda, in print). The examined subjects received on one forearm an injection of toxoplasmin and on the other — the trichinella antigen produced by the authors from the cleaned and lyophylized larvae *Trichinella spiralis,* diluted with physiological solution to 1 : 5,000 or 1 : 10,000. As controls served pure physiological solution injections. Simultaneously read results are shown in table IV. They are particularly interesting in the light of Weinman and Chandler's (1956) studies, conducted on similar lines.

Table IV

Comparison of results with toxoplasmin and trichinella antigen

Toxo. — Trich. —	Toxo. + Trich. +	Toxo. + Trich. —	Toxo. — Trich. +
667 = 50%	190 = 14%	805 = 23%	164 = 12%
857 = 65%		469 = 35%	

The numbers of examined persons shown in table I, II and III are sometimes too low, to draw on their basis concrete conclusions. To increase the reliability of the cited indicators they were represented in total numbers but simultaneously are represented limits of experimental error according to the generally accepted formula:

$$m = \sqrt{\frac{p \cdot (100 - p)}{n}}$$

Discussion

In the cited work, dealing also with examinations of the inhabitants of Gdańsk, we reported on page 207 results represented in table 6, showing results of similar studies conducted by other investi-

gators, known from the literature (K o z a r, 1953). In the last years there appeared naturally a number of new works, but not all will be taken into consideration in the present paper.

Studies with toxoplasmin, similar to our's were conducted in the United States of America. Among the healthy inhabitants of Pittsburgh a very clear increase of positive reactions was found with the advance of age: 0—4 years 5%, 5—9 years 10%, 10—29 years 25—30%, 30—39 years 45%, 40 and above 65—70% (F e l d m a n, 1952). In the Louisiana state children not suspected of toxoplasmosis were examined and it was found that positively reacting were in the group 0—4 years 7.6%, 5—9 years 22.7%, 10—15 years 83.3% (H u m p h r i e s et al., 1952). In the two works the results are strikingly high, particularly in the second work. May be, that the cause lies in not numerous groups of the examined subjects, particularly in the latter work (13, 22 and 6 persons).

Among the inhabitants of Mexico V a r e l a (1955) found on the average 13% of positively reacting to toxoplasmin. I should also mention that the author used simultaneously the dye-test and attained an agreement of the results in 93% cases. In Johannesburg Negroes of the Bantu tribe were examined. They were normal patients of a hospital (S c h n e i d e r et al., 1955). In the total number of 209 examined positively were reacting 31.1%. A group of 25 children up to 9 years reacted negatively, and the highest positive percentage (43.8%) was found in the group 30—39 years. In the oldest persons (50—81 years) there appeared a decline of the skin allergy and a lower result (37.7%).

In Barcelona in 1,053 examined inhabitants there were positively reacting 27.6% (S o l e r D u r a l l and V. V i ñ a s, 1955). Similarly also here the highest percentage (53.6%) included people at the age 30—40 years. P i g e a u d et al. (1953) found among the normal inhabitants of Lyon only 6.4 and 11.8% positive results.

Particular attention should be paid to studies conducted in Sweden. In Stockholm among 371 adult men there were positive results in 45.6% of cases and among 513 women 46.4% (G a r d, 1951). The highest percentages (50%) appeared in the group 30—50 years. The author reported that in the same period in the northern regions of the country (in Boden) K o s t m a n examined 173 persons, age 20—50 years and found only 9.8% of positive reactions. Among the positive reacting as many as 9 persons were from the southern regions,

what jointly with the total result may prove that toxoplasmosis is in the northern part of the country extremely rarely occurring. H a g b e r g (1953) examined in Stockholm children and obtained positive results increasing with the age: 114 children 7—8 years 8.8%, 174 children age 9—10 years 14.9%, 99 children 11—12 years 16.2%, 43 children age 13—14 years 18.6%. The high agreement with G a r d's results for the corresponding groups of age should be stressed (156 children 8—10 years 14.1%, 128 children 11—15 years 16.4%).

The most interesting for us are the results from neighbouring countries Germany and Czechoslovakia. In Freiburg among 238 inhabitants 53% of positive reactions were proved (S c h m i d, 1952) and in Berlin among 170 — 26.5% (F a l c k, 1953). In Czechoslovakia J i r o v e c (1957) uses fairly extensively the intradermal test. In various groups of the population, which can be classified to the so called normal population, in the total number of 2,120 examined persons the author proved an increase of the percentage, related to the age (1—5 years 2%, 6—16 years 10%, 16—40 years 15%, above 40 years 20%). The result is similar to our's obtained in Gdańsk.

The above cited examinations and studies were conducted by the use of toxoplasmin and referred to the so called normal population, that is to persons healthy or sick, but not suspected of toxoplasmosis. The same conditions refer to our material. However, it should be stressed, that in the literature we find even more numerous investigations, but performed by the use of serological reactions. Of this latter group I should mention the work of R a w a l et al., 1955; M e r c i e r and P a n g a l o s, 1956; M a n n i n g and R e i d, 1956; V a r e l a et al., 1956. From those and other works not mentioned here we can to a certain degree draw conclusions and make use in our present considerations as regards epidemiological conclusions.

The mean result 39% obtained by us does not differ fundamentally from the above cited results. It is higher than the results obtained in Czechoslovakia, Germany or Spain, but is lower from those obtained in Sweden or Austria (T h a l h a m m e r, 1953). We have to consider, however, the fact of an essential difference between the population of Gdańsk and the Białystok palatinate. These results we can exactly compare because in the two cases the same conditions were preserved. The same, unfortunately cannot be the case with all other authors, who sometimes, as e.g. H e d q u i s t (1953), used toxoplasmin produced on chicken embryos.

It seems that both our results as also the results of other authors show sometimes considerable fluctuations as regards the percentage of the obtained results on the individual terrains. Studies of Feldman and Miller (1956), based on the dye-test, but including the same criteria are a striking example. The authors examined jointly 1,747 healthy persons and discerned among them 10 populations, depending on the locality of their living. They obtained the following, sometimes extremely different results: Eskimoes 0%, Indians Navajo 4%, Iceland 11%, Portland 17%, St. Louis 26%, New Orleans 31%, Pittsburgh 35%, Haiti 36%, Honduras 64%, Tahiti 68%. The work deals with terrains separated one from the other by very long distances and characterized by different epidemiological conditions. Let us take as an example the studies of Jirovec (1957), limited to the territory of Czechoslovakia and we find also not small fluctuations between e.g. the group of Gypsies from eastern Slovakia and the group of workers from Prague. Similar differences were shown by Krieg (1951) for Western Germany finding in Lower Saxony and Schlezwigholstein 64.1% and in northern parts of Rhine and Westphalia 40.8%. Also Grönroos (1955) discerns in this respect various zones in Finland.

Differences appearing even on the terrains of the same country point to different epidemiological conditions and thus justify investigations of this kind. There is no doubt that in the course of mass examinations a control group should be selected among the normal population inhabiting a given terrain. It happened that a particular group was studied and conclusions were drawn from comparison with results of other studies.

As regards the cause of difference of results in Gdańsk and Białystok palatinate in the first line there appears to be a difference of the character of the examined population. In Gdańsk into consideration were mainly taken townsmen and in the Białystok palatinate mainly peasants. Considering that toxoplasmosis is a zoonosis and peasants come in contact with animals more frequently we attain a would-be explanation. But the problem reviewed in the light of the literature takes a different aspect.

Piekarski and Peters (1950) found that the inhabitants of Bonn show a positive titre in the dye-test in 7.5% of cases and the inhabitants of the neighbouring rural districts in 20% of cases. This result, confirming the logical reasoning, was for a long time cited

in the literature dealing with epidemiology of toxoplasmosis. In meantime other works appeared, which denied the generally accepted principle. Both Krieg (1951) and Grönroos (1955) were not able to observe conspicuous differences between the municipal and rural population. It is true that the latter mentioned author found higher percentages in the southern parts of Finland, particularly in the locality Turku as compared with Helsinki, but on the basis of a general analysis he explains the fact by fluctuations dependent on the area. Some investigators achieved quite opposite results, higher percentages in towns than in rural districts, e.g. Roth and Fritz (1950) drawing a comparison between the population of university towns in Switzerland and the inhabitants of alpine rural areas. In this particular case special geographical conditions must be admitted and reservations can be made, because the results are based on only 207 examined subjects. Let us take another examples. Harboe (1952) found among blood donors inhabiting Oslo 17% positive reactions and among the inhabitants of neighbouring areas only 10%. Similarly Pigeaud et al. (1953) report for urbane population 12.9% and for rural population 7.4%. Recently this problem was closer invastigated by Gibson (1956). He examined 627 Negroes from towns and 445 from rural districts, all being in the same age group 11—19 years. Because no detectable differences could be found the author concludes that in the two environments there operate the same factors responsible for the spreading of toxoplasmosis.

On the basis of the cited works we must reject the rule of the presence of constant differences between the urbane and rural populations, although in certain cases they are found. It appears that only the contact with animals cannot serve as a sufficient argument. If toxoplasmosis is contracted only directly from animals then also animal products must play not a small role, and the contact with these products may be even for the urbane and rural populations.

In our further investigations to find the cause of the differences found by us attention should be turned to different living conditions of the two groups. The population of Białystok palatinate, contrary to the inhabitants of Gdańsk, is in the majority poor and lives on a relatively low level of hygienic conditions. May be that this factor is responsible for the spreading of toxoplasmosis, although we still lack a basis to generalize it and except geographical differences we should rather think of a larger set of epidemiological factors.

The above theses are even more confirmed by the tabular arrangement represented in table I. In the individual localities of the same palatinate we observe considerable local fluctuations (from 19 to 76%). It is true that a decisive role is played here by the age of the examined persons (e.g. in Zambrów and Sokółka youth was in the majority), but anyway, we do not find a confirmation of the thesis that the positive reaction to toxoplasmin appears more frequently among the rural than among the urbane population. We do observe conspicuous differences dependent on the separate localities. Investigations of still more numerous groups of populations based on the use of the same criteria (age, profession, etc) would possible enable to draw more concrete conclusions within this palatinate.

Both our previous investigations in Gdańsk and the present indicate sufficiently clearly that there are differences of the percentages between the women and men. As shown in table II, in spite of the fact that the group of younger women was more numerous (484 women, age 11—20 years), the total percentage for women is considerably higher (44%) as compared with the group of men (30%). It is true, that the majority of investigators did not find any difference between the examined persons of both sexes, but in cases when they are found the indices for women are on the whole higher than for men (H a r b o e, 1952; G r ö n r o o s, 1955, etc). According to K u d i c k e and P ö h l i n g (1954) the percentages of positively reacting women in relatively large groups (1,234 and 2,194 persons) are higher of 13.5 and 18.7% than the analogous groups of men. They are of 6 and 6.9% higher than the mean percentage of the whole examined population. Our differences are not so conspicuous.

It appears that the living conditions of women, particularly in rural areas create more chances of invasions than in the case of men. There is no doubt that women have a closer contact with animals and particularly with products of animal origin both on the farm and in house-keeping. Such chances are even during the preparations of meals.

Astonishing are also the higher percentages shown in table II for young women in comparison with a similar group of men. The same is represented in the mentioned work of K u d i c k e and P ö h l i n g. This would indicate that women become invaded earlier with toxoplasmosis than men. In groups of older age the differences are not so conspicuous.

In the present studies there appears a relation between the positive results and the age of the examined persons (table II) although not so clearly as in works of other previously cited authors. In the general calculation we observe a relatively small increase of the percentage from 30 to 50, whereby the highest percentage appears in persons above 50 years old. Generally, however, the highest percentage appears in the groups 30—50 years. After the age of 50 years there appears a decrease explained by exhaustion of the allergic properties of the skin. In our tabular arrangement are seen certain differences between women and men. The highest percentage for women (57%) appears in the group 41—50 years.

The not very distinct course of the relatively characteristic normally curve may be interpreted by the relatively not numerous in our work group of children, therefore the freedom of error is higher (13.2 and 11.6). Also the youth shown in the column 11—20 years was represented in the majority by persons 18—20 years old, a fact which exerted its influence on the general percentage of this group.

Some authors see as the essential epidemiological factors the occupation of the examined persons. The closer contact of the subjects with animals revealed itself mainly in higher percentages of the reaction. Most commonly were concerned breeders, hunters and veterinary surgeons. Kudicke and Pöhling (1954) proved among 254 workers of a meat factory 81.5% of positive reactions, therefore 10% more than in the control group of the same age (71.9%). This was partly confirmed by investigations of Starzyk et al. Beverley, Beattie and Roseman (1954) arranged according to the increasing positive percentages the following professional groups: controls, workers in abattoirs, veterinary surgeons, rabbit dealers, hunters of rabbits. According to the authors, therefore, a contact with free living rabbits would most frequently be responsible of invasions. I should mention, that Feldman and Miller (1956) criticized this conclusion proving that all the enumerated groups were inhabitants of different localities and exactly this fact could be the cause of the differences.

Grönroos (1955) considers a classification of the examined persons according to their social state, but introducing as many as 8 groups, and in every group 2 subgroups, he operates with relatively low numbers and gets entangled in his final conclusions. A cer-

tain difference (higher percentages), however, he observed in the group of agricultural workers.

Our results are represented in table III and are arranged in 5 groups. The groups are naturally not of equal rank separated strictly according to the same criteria. Sometimes they arose accidentally during closer analysis of the results (e.g. the last group) although on the whole as a rule was accepted the criterium of the contact with animals on the basis of the thesis that toxoplasmosis is in the proper meaning of the word a zoonosis. This latter refers mainly to a group of physical workers as opposed to the group of agricultural workers. The first group is represented by factory workers and really shows the lowest percentage (24%), considerably even lower than the average. The group of agricultural workers, however, reacts in 45%. To this group belong rural population as also women house-keepers in settlements and boroughs. In the two compared groups the percentages for women are higher than the corresponding values for men, particularly in the group of agricultural workers.

Interesting are results concerning the school youth and intelligentsia. Among the first a considerable preponderance has the rural youth and this fact should be here stressed. It is known that children come in contact with animals in the rural areas at a very early age. Almost in every house there is a dog and cat which become playmates of children at very early age. The group of intelligentsia, however, is relatively numerically small, therefore the probability of error is here considerable higher. To this group were classified also workers in small institutions in rural areas or small villages and many of them were engaged in breeding if only small animals (rabbits, pigeons etc). May be that the classification of people of this group was not appropriate.

The most interesting is the last group which includes sanitary personnel, in the majority nurses, midwives and ward-sisters. The mentioned persons originated from various localities, various hospitals, health centres etc., therefore the above mentioned F e l d m a n and M i l l e r' s objection as regards differences in individual localities cannot be uptaken here. (As to the objection, we share the authors' opinion). Among 167 women of this group we found as many as 71% of positive results, in spite of the fact that the majority of the women were young persons. Men showed a lower percentage, but

they actually are not occupied directly with the patients. Involuntarily the conclusion rises, that exactly this direct contact with the patients, with their discharges etc, may be the cause of the difference. In small provincional hospitals, where such studies were introduced, the nurses and ward-sisters perform diverse functions, often under not too favourable sanitary conditions. If such a possibility of contracting invasion from patients suffering from toxoplasmosis were actual, and such persons undoubtedly will be admitted to hospitals, then our suggestion would be totally justified.

Naturally, the mentioned hypothesis requires further evidences particularly in the view of the fact, that hitherto such a possibility of invasions of the man from a man has not been taken into consideration and in every case the animal is looked at as the source of the microorganism.

The group of physicians and nurses in the studies of Jirovec (1957) reacted positively in 22 and 30% of cases depending on the age. This group reacted therefore also more frequently than the average population. Most likely these persons formed the personnel of larger hospitals and clinics, in which prevail considerably better sanitary conditions. It appears that this is an essential factor. Other authors, although sometimes mention of the examination of the sanitary personnel, do not separate this group, may be therefore that the group is not numerous.

The last problem risen by us is the correlation of the toxoplasmosis and trichinellosis reactions. After the completion of our studies appeared the work of Weinman and Chandler (1956), who found among 40 positive sera to trichinellosis almost twice as frequent in comparison with the titre 1 : 64 of the dye-test of the average population and almost three times as frequent reactions in respect to the titre 1 : 256. On the basis of experiments they excluded the possibility of cross-reactions between trichinellosis and toxoplasmosis. In further studies the procedure was reverse. In the group of 57 human positive to toxoplasmosis sera 21% reacted in the flocculation test on trichinellosis, which, according to the authors detects only fresh invasions with trichinella contracted few months before. Examining consequently 88 pigs fed with meat by-products the authors found 48% cases of positive titres of the staining reaction. They showed further that the toxoplasmas may survive in pork at least 10 days at 2—5°C., and in the brain up to 30 days. The authors

succeeded to invade with this material 2 monkeys per os and detected subsequently high levels of antibodies. However, in experiments in vitro the toxoplasmas preserved their ability to invade in pieces of liver submitted to the action of artificial digestive juices during a period corresponding to the time the food is retained in the stomach.

On the basis of the mentioned studies the authors suggested the hypothesis that people become invaded with toxoplasmosis in a similar way as with trichinellosis, that is by means of pork not sufficiently cooked. Naturally almost every case of trichinellosis originates from pork, what cannot be said of every case of toxoplasmosis. The authors suggest also that pigs become invaded with toxoplasmosis by means of meat by-products or by eating rodents.

G a r n h a m summarizing the above work in the Trop. Dis. Bull. (54, 2 : 215, 1957) submits to critic the drawing of conclusions on the basis of serological studies, because it is known that pigs are very often invaded with *Sarcocystis,* and these protozoa, as shown by studies of A v a d and L a i n s o n, give false positive reactions in the dye-test of Sabin-Feldman to toxoplasmosis.

Not engaging ourselves in the partly still questionable problem of the antigenic affinity of *Toxoplasma* and *Sarcocystis,* we must agree that the reasoning of the American authors is fairly bold and the conclusion is not based on too solid grounds. Nevertheless the hypothesis is interesting and we decided to verify it by the use of our method, that is the intradermal test, which seems to be more suitable than the serological reactions even in view of the eventuality of the above mentioned objections and greater permanency of the trichinellosis allergic reactions than that of antibodies shown by the flocculation test. We have to our disposal a relatively numerous material including 1,326 persons, in whom the two reactions were performed simultaneously.

As revealed by the analysis of our studies represented in table IV most commonly appeared agreement of negative reactions noted in 667 persons, that is in 50% of the cases. Agreement of positive results of both tests appeared in 190 persons, that is in 14% of the cases. Totally therefore we attained 64% agreement of results of the two reactions. This is a higher percentage than the average for positive tests with toxoplasmin, and even more than with the trichinella antigen.

We should like to stress that the Białystok palatinate is an exceptionally suitable terrain for studies of this kind, because, as will be proved, it constitutes an unusually intense centre of trichinellosis in Poland and even in the world and of a relatively commonly occurring toxoplasmosis prove the data already discussed.

It is, however, difficult on the basis of our results to draw final conclusions, which would to a certain degree support the hypothesis of Weinman and Chandler. More than 35% of reactions which are in disagreement prove that there are besides pork other epidemiological factors different may be for toxoplasmosis and trichinellosis.

It is true that our analysis did not reveal yet concrete epidemiological conclusions, but suggests certain hypotheses, which should be supported by stronger arguments. It seem reasonable to undertake studies of this kind also on other terrains, in other environments and under other conditions, naturally by the use of methods, which would enable a closer comparison of the results.

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STRESZCZENIE

Wobec dużych trudności w rozwiązaniu najważniejszych zagadnień w epidemiologii toksoplazmozy (np. częstość zarażeń i ich zależność od różnorodnych czynników, drogi naturalnych zarażeń człowieka, itp.) wydaje się celowe prowadzenie badań masowych wśród ludności zdrowej. Wysunięte wnioski mogą wskazywać kierunki dla bardziej konkretnych poszukiwań. Istotnym jednak warunkiem przydatności tych prac jest stosowanie jednolitej metodyki, co pozwala na porównanie wyników uzyskanych w różnych okolicach. Ponieważ dotychczas nie zostały uzgodnione wszystkie szczegóły odnośnie wykonywania prób serologicznych, zwłaszcza barwnej (np. schemat rozcieńczeń, ocena mian dodatnich), najbardziej dogodna w tej chwili wydaje się metoda alergiczna z toksoplazminą. Jej przebieg oraz wartość prześledziliśmy już w innej pracy (K o z a r, 1953). Stwierdziliśmy m. in., że wśród zdrowych mieszkańców Gdańska występuje średnio 25% reakcji dodatnich. Obecne badania, jako kontynuacja dawniejszych, prowadzone były na innym terenie, a mianowicie w woj. białostockim, leżącym na północno-wschodnim krańcu Polski. Toksoplazminą własnej produkcji przebadaliśmy 1410 osób zamieszkałych w 19 różnych miejscowościach (przeważnie wsiach) obejmując tym samym niemal cały teren województwa (rys. 1). W większości byli to ludzie zdrowi, a poza tym różni chorzy przebywający w szpitalach, nie podejrzani jednak o toksoplazmozę. Jest to więc dość reprezentatywny materiał normalnej populacji danych terenów.

Ogólny wynik odczynów dodatnich (39%) w porównaniu z uprzednio uzyskanym (25%) oraz dość znaczne różnice uzyskane w poszczególnych powiatach (tab. I) potwierdzają tezę o nierównomiernym występowaniu zarażeń toksoplazmowych w poszczególnych miejscowościach (F e l d m a n i M i l l e r, 1956). Bliższa analiza wyników w oparciu o piśmiennictwo nie pozwala nam na wytłumaczenie różnicy między ludnością Gdańska (25%) a Białostocczyzny (39%) jedynie charakterem ludności, w pierwszym przypadku miejskim, a w drugim przeważnie wiejskim. Raczej można tu wziąć pod uwagę niższy stopień sanitarny ludności drugiej grupy.

Podobnie jak w pierwszych badaniach, tak i tym razem, uzyskaliśmy wyraźnie wyższy odsetek dodatnich reakcji dla kobiet (44%) niż dla mężczyzn (30%). Mimo że większość autorów stwierdza brak różnic zależnych od płci, wydaje nam się, że warunki życia i pracy

kobiet, szczególnie wiejskich, bardziej predysponują je do zarażeń toksoplazmą. Może w tym przypadku czynnik wsi odgrywa jakąś rolę. Podobne zresztą, a nawet wyższe różnice uzyskali K u d i c k e i P ö h l i n g (1954). Z tab. II wynika też, że kobiety zarażają się toksoplazmozą w młodszym wieku aniżeli mężczyźni. Ponieważ w ogóle kontakt ze zwierzętami jest znacznie większy u dzieci wiejskich niż miejskich, stosunkowo wysokie procenty w tych grupach wieku świadczą o normalnie wczesnych zarażeniach. U starszych wiekiem grup różnice między ludnością miejską i wiejską bardziej się zacierają. Może z tych powodów krzywa zależna od wieku nie miałaby u nas tak charakterystycznego przebiegu jak w pracach innych autorów. Ma ona u nas nieco inny przebieg dla kobiet niż dla mężczyzn, co zostało uwidocznione w tab. II.

Poszukując innych czynników epidemiologicznych wydzieliliśmy wśród 1396 osób 5 grup zależnie od zawodu i trybu życia (tab. III). Jeżeli myślimy o kontakcie ze zwierzętami, najlepsze do porównania są grupy robotników fizycznych, przeważnie fabrycznych, oraz rolników, do których zaliczyliśmy też gospodynie domowe. Dodatnie reakcje u pierwszych w 24% i u drugich w 45% potwierdzają do pewnego stopnia słuszność założenia. Stosunkowo nieliczne grupy młodzieży szkolnej (przeważnie wiejskiej) i pracowników administracyjnych (którzy na ogół żyją w podobnych warunkach jak rolnicy) nie są reprezentatywne.

Najbardziej zastanawia ostatnia grupa, obejmująca personel sanitarny, tj. przeważnie pielęgniarki, położne i salowe z różnych prowincjonalnych szpitali, ośrodków zdrowia, itp. Wśród 167 kobiet, w większości młodych, wykazaliśmy 71% wyników dodatnich. Mimo woli nasuwa się wniosek, że przyczyną wysokiego wyniku może być bezpośredni kontakt tych osób z chorymi. Trzeba zaznaczyć, że ujęty w tej grupie personel pracuje w znacznie gorszych warunkach sanitarnych aniżeli podobny w szpitalach czy klinikach miejskich. Gdyby istniała możliwość bezpośredniego zarażania się od chorych ludzi na toksoplazmozę, a tacy niewątpliwie trafiają do powyższych szpitali, to nasza sugestia byłaby w pełni uzasadniona. Obecnie nie posiadamy jednak żadnych dowodów na poparcie tej tezy.

W e i n m a n i C h a n d l e r (1956) wysunęli niedawno śmiałą i oryginalną hipotezę, że mięso wieprzowe jest ważnym wspólnym źródłem dla zarażeń tak trychinellozą, jak i toksoplazmozą. Stosowaną przez nich metodę prób serologicznych poddał krytyce G a r n h a m

(Trop. Dis. Bull., 1957). Przyjęcie metody prób śródskórnych wydaje się więc korzystniejsze. U 1326 osób wstrzykiwaliśmy jednocześnie z toksoplazminą antygen trychinellowy (wg Witebsky'ego) rozcieńczony 1 : 10 000 i płyn fizjologiczny dla kontroli. Uzyskane wyniki przedstawia tab. IV. U 667 (50%) osób wystąpiły zgodnie ujemne reakcje, a u 190 (14%) zgodnie dodatnie. Prawie 65% wyników zgodnych może sugerować poparcie tezy Weinman'a i Chandler'a. W każdym razie nie można jej przyjąć jako ogólnej zasady, gdyż brak nam na to dowodów, a poza tym u 35% osób wystąpiły wyniki niezgodne. Białostocczyzna stanowi wyjątkowo silne ognisko włośnicy w Polsce, a nawet w skali światowej, co zostanie omówione w innej pracy (Kozar, Kołłoto i Warda).

W niniejszej pracy zostały przedyskutowane dość liczne wyniki innych autorów, szczególnie dotyczące badań epidemiologicznych wśród normalnej ludności i wykonane przy pomocy próby śródskórnej.